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(54) Hydraulic System for a Hydraulic Element intended for the Construction of Tools used for Drawing- and Forming Operations or the like.

(57) Within a working cylinder of the hydraulic element are contained two pistons, arranged co-axially relative to each other and in each instance jointly activatable from the rear. One of said pistons is assigned a differential zone, activatable by flow pressure medium [flowing] in the opposite direction of its rear-sided actuation, said differential zone sealing an actuation chamber connected to a pressure reservoir. An actuation chamber sealed by the rear-sided actuation areas of the two pistons is likewise connected to the pressure reservoir. In an appurtenant pressure medium line is located an adjustable pressure reduction valve, which, in case there occurs a certain pressure difference, admits only flow of hydraulic medium towards the named actuation chamber. Parallel to said pressure reduction valve is arranged another adjustable pressure reduction valve, which permits flow of hydraulic medium only in the direction towards the pressure reservoir.

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Patent Specification

The invention relates to a hydraulic system for a hydraulic element intended for the construction of tools used for drawing- and forming operations or the like, which comprises within one working cylinder two, relative to each other, co-axially arranged and, in each instance jointly from the rear activatable pistons, and also a differential zone, which is assigned to one of said pistons and whose rear-sided actuation in the opposite direction can be activated by flow medium pressure.

A hydraulic element of this kind as well as a tool for deep-drawing of sheet metal using this type of hydraulic element is described in DE-OS 36 20 876.

With respect to the prior known hydraulic element, a central working piston and a rotary piston surrounding same are arranged in a joint working cylinder. The pistons brace themselves at the rear against a hydraulic medium filling agent of the working cylinder, they are activatable in the opposite direction and are arranged in the working cylinder in co-axial arrangement vis-a-vis each other. The hydraulic medium filling is proportioned in such fashion that the rotary piston is in its fully extended position when the working piston is in its retracted position, or the working piston is in its fully extended position when the rotary piston is in its retracted position.

With movement of the one piston from its fully extended position into the direction towards its retracted position, flow pressure medium of the hydraulic medium filling is displaced by said piston and said flow pressure medium then actuates, from the rear, the other piston conducted in the working cylinder, said piston thus being propelled in the opposite direction relative to the movement direction of the first-named piston.

The working piston of the prior known hydraulic element is designed as differential piston, which has a differential zone facing in the opposite direction from its rear-sided actuation zone, said differential zone being likewise activatable by the flow pressure medium. The working piston has a central cylindrical center recess and, co-axially relative to the working cylinder, extends a cylindrical prolongation from a base plate, closing said working cylinder at the rear, said cylindrical prolongation being firmly connected with the base plate and presenting a head engaging with the cylindrical center recess of the working piston. A ring element screwed into the central center recess of the working piston, which concentrically surrounds the cylindrical prolongation, forms the differential zone, which, in contrast to the rear-sided actuation of the working piston, can be activated by flow pressure medium from an interior activation chamber between the named ring element and the head of the cylindrical prolongation. Given said working piston design, it can be returned from a forward position into its original position as a result of its differential zone being activated by flow pressure medium.

With respect to a drawing tool constructed by utilizing the discussed hydraulic element, the drawing punch of the tool supports itself on the central working piston, while the hold-down device surrounding the drawing punch is arranged on the ring piston positioned co-axially vis-a-vis the working piston and surrounding the latter. The hold-down device and the ring piston of the hydraulic element accepting same are, at the onset of a drawing operation, in their upper positions, in contrast to the lower end position of the working piston and the drawing punch arranged on same.

When, during the drawing operation, the hold-down device and the ring piston descend under the influence of a down-going press ram, the working piston and the drawing punch arranged thereon are propelled in the opposite direction relative to the hold-down device movement due to rear-sided activation of the working piston by the flow pressure medium of the working pistons displaced by the descending ring piston.

The drawing operation is thus broken down into a partial drawing step controlled by the descending hold-down device and a partial drawing step produced by the ascending drawing punch.

The forming technology realized with the above explained hydraulic element has proven its worth. Aside from its technical shaping possibilities, there exists a special benefit in that the pressure energy from the flow pressure medium displaced during the descent of the ring piston -which supports the hold-down device in a drawing tool - can be exploited in order to drive the working piston which is movable in the opposite direction; said working piston accepting the drawing punch in a tool of this type.

It is the object of the present invention to create a hydraulic system for a hydraulic element of this kind which affords, in addition to movement of the two pistons in the opposite direction, also their movement in the same direction, as well as unproblematic topping-up with hydraulic medium.

Said stated goal is of importance, for example, in regard to combination drawing- and cutting tools, to the extent that at the end of a drawing operation the work piece must be altogether lowered in the interest of a subsequent cutting operation. This means that the two pistons of the hydraulic element must then be moved out of their rear-sided actuation zone, under displacement of flow pressure medium, in the same direction towards their lower end positions.

Said object is solved in that with the hydraulic system according to the Preamble of Patent Claim 1, a central activation chamber of the hydraulic element, which is sealed by the differential zone of the working piston is connected, on the one side, via a pressure medium line and, on the other side, an activation zone sealed by the rear-sided activation zones of the two pistons is connected via another pressure medium line with a pressure reservoir, which is under

pre-specified flow medium pressure, that in the last-named pressure medium line is arranged an adjustable one-way pressure reduction valve, which permits hydraulic medium flow only from the pressure reservoir to the named activation zone of the hydraulic element when a pressure difference between the inflow- and outflow side occurs which is greater than the value respectively established at the valve, and that in parallel-switching relative to the aforementioned pressure reduction valve, in a parallel branch to the pressure medium line containing the named pressure reduction valve, there is arranged another adjustable one-way pressure reduction valve, which only permits flow of hydraulic medium from the activation zone of the hydraulic element, sealed by both pistons, to the pressure reservoir, if the pressure difference between the inflow- and outflow side of said valve is greater than the value established for the latter.

The invention thus involves that the central activation chamber is located in the working piston, directly at the pressure reservoir of the hydraulic system and, consequently, is constantly acted upon by the flow medium pressure from the pressure reservoir, whereas an exchange of hydraulic medium between the hydraulic element actuation space - sealed off by the rear-sided actuation zone of the two pistons - and the pressure reservoir takes place only via pressure reduction valves, which respectively permit flow in opposite directions only, and which are located, in parallel-switch arrangement vis-a-vis each other, in the pressure medium line extending from the pressure reservoir to the named actuation zone.

In a tool constructed with the use of the above discussed hydraulic system for drawing and subsequent cutting of the drawing part, the drawing operation takes place in the above explained manner, whereby, however, the arrangement has been designed in such fashion that at the end of the drawing process, the ring piston accepting the hold-down device is still standing, away from its lower end position, by a pre-specified measure. For purposes of cutting the drawing part,

same must altogether be lowered down vis-a-vis the fixed cutting edges of the tool, which is tantamount to a joint downward movement of the two pistons of the hydraulic element.

Said joint downward movement of the pistons results in a rise in pressure in the rear-sided actuation zone in excess of the value established for the pressure reduction valve located in the parallel branch, resulting in out-flow of flow pressure medium via said pressure reduction valve from the named actuation zone to the pressure reservoir.

When at the end of the cutting operation the press ram is raised upwards, the rear-sided actuation zone of the two pistons becomes practically devoid of pressure and, in view of the actuation of the differential area of the working piston with the flow medium pressure of the pressure reservoir, the central working piston remains in its lower end position or moves into said position, in case the working piston had not as yet reached its lower end position at the end of the cutting operation. In view of the drop in pressure which occurs after the cutting operation in the rear-sided actuation zone of the two working pistons, the resulting pressure difference occurring in the pressure medium line leading from the pressure reservoir to the actuation zone, exceeds the value established at said valve and, accordingly, hydraulic medium flows from the pressure reservoir to the named actuation zone. The result is that the then practically unburdened ring piston moves into its upper position, while the working piston - given actuation of its differential area with the flow medium pressure of the pressure reservoir - remains in its lower end position. When the ring piston has reached its upper end position, there develops flow medium pressure in the rear-sided actuation space of the pistons until such point in time when the pressure difference at the named pressure reduction valve falls below the established value and said valve shuts off. Thus, the initial position has again been attained.

One suitable embodiment of the invention-specific hydraulic system provides that from the hydraulic medium line leading to the rear-sided actuation zone of the pistons of the hydraulic element , between the pressure reduction valve arranged in said line and the pressure reduction

valve arranged in the parallel branch, on the one hand, and the pressure reservoir on the other hand, there continues an extension of a hydraulic medium line which issues in a hydraulic medium tank and into which is inserted another adjustable one-way pressure reduction valve which permits only flow towards the hydraulic medium tank if the pressure difference between the inflow- and outflow side occurring at said pressure reduction valve is greater than the value set at the valve.

Via said line and the named pressure reduction valve, which is adjusted to a higher value than the other pressure reducing valve which facilitates outflow of flow pressure medium from the rear-sided actuation zone of the two pistons, flow pressure medium can flow out of the named actuation zone directly into hydraulic medium tank if there occur inadmissibly high pressures in the system. This results in preventing damage to the hydraulic element and the hydraulic system.

Another embodiment provides that in the invention-specific hydraulic system, the hydraulic medium tank is connected with the pressure reservoir via a line equipped with a conveyor pump and a one-way recoil valve, permitting transport of hydraulic medium only from the tank to the pressure reservoir and that between pressure reservoir and hydraulic medium tank there extends a line fitted with a shut-off organ which can be operated between an open and a closed position, said line facilitating, if the shut-off organ is in open position, direct transfer by pumping of hydraulic medium. A measure of this kind is of importance to the extent that a cooler is inserted into the circulatory flow and that for cooling purposes the hydraulic medium can be pumped through same.

The appended drawing explains the construction of a hydraulic element intended as a tool for drawing-, forming- and similar operating procedures and a hydraulic system intended therefor.

The schematic views depict the following:

Fig. 1 - shows the hydraulic element with a central working piston designed as differential piston and with a ring piston, arranged co-axially to same, which are conducted axially movable within a working cylinder and which can be activated jointly at the rear by means of flow medium pressure, depicted in semi-sectional views indicating two different operating positions, and

Fig. 2 - shows a hydraulic system for the hydraulic element depicted in Fig. 1.

With respect to the hydraulic element 10 shown by itself in Fig. 1, there are conducted, in axially movable fashion, within one working cylinder 11, consisting of a cylinder sleeve 12 and a base plate 13, firmly accepting same, a central working piston 14 and a ring piston 15 concentrically surrounding the latter. The two pistons 14, 15 can be actuated from the rear with hydraulic medium, in a manner to be described below. By means of schematically intimated O-ring seals 16, 17 or 18, the ring piston 15 is sealed off from the cylinder sleeve 12 of the working cylinder, on the one side, and from the central working piston 14, on the other side.

The central working piston 14 has a center recess 20 starting from the side facing away from the base plate 13 of the working cylinder, with acceptance in said center recess 20 of a piston-shaped head 21 of a cylindrical prolongation 22, which continues to extend, - co-axially relative to the working piston - from the base plate 13 of the working cylinder and which is firmly connected with same.

The cylindrical prolongation 22 presents a smaller diameter than the head 21 accepted in the center recess 20 of the working piston 14. The head 21 of the cylindrical prolongation 22 is

sealed off vis-a-vis the walls delineating the cylindrical center recess 20 of the central working piston 14 by O-ring seals 23 accepted in ring grooves of the head. The side of the cylindrical center recess 20 of the working piston 14 facing toward the base plate 13 of the working cylinder is closed off by a ring element 25 which is screwed in by means of threading 24; said ring element, in turn, concentrically encloses the cylindrical prolongation 22, which is firmly connected with the base plate 13 of the working cylinder and which is sealed off - flow-medium-tight - from same by means of an O-ring seal 26, likewise accepted in a ring groove, and which has, in the opposite direction from the rear-sided actuation of the working piston 14, an activatable differential area 27.

Between the ring element 25 surrounding the cylindrical prolongation 22, which is screwed in by means of threading into the central center recess 20 of the working piston 14, and the piston-like designed head 21 at the free end of the prolongation, there extends a circular ring-shaped actuation chamber 28, which can be activated by flow pressure medium via a channel 29 extending through the base plate 13 of the working cylinder and the cylindrical prolongation 22. Likewise activatable by means of flow pressure medium is the actuation zone 32 of the working cylinder, said actuation zone 32 of the working cylinder being closed off, on the one side, by the rear-sided actuation areas 30 and 31 of the working piston 14, and, on the other side, by the ring piston 15, via a flow path 33, extending through the base plate 13 of the working cylinder.

In the respective lower end position, the moving capacity of the pistons 14, 15 is limited via placement on the base plate 13. The upper end position of the central working piston 14, is, however, determined by an annular flange 35 on the side of the piston-like head 21, pointing towards the prolongation 22. The ring piston has at its end which points towards the base plate, a radially protruding edge flange 36, which is accepted in an axially extending radial bore 37, that originates from the base plate 13 and continues in the cylinder sleeve 12, and which runs up in the

upper end position against a shoulder 38, which axially limits the bore, as is shown in the left half of Fig. 1.

The hydraulic system 40 indicated in Fig. 2 comprises a pressure reservoir 41, which can be connected via two high-pressure lines by means of known flow medium couplings 42, 43, with the actuation chamber 28 in the central working piston 14, on the one side, and on the other side, with the actuation space 32 of the working cylinder, which is closed by the rear-sided actuation areas 30, 31 of the two pistons 14, 15, - it can also be shut off vis-a-vis said lines by means of a manually operable shut-off valve 44. Line 42 which can be connected with the actuation zone 32 of the working cylinder is equipped with an adjustable pressure reduction valve 45, which permits only one-way flow from the pressure reservoir 41 to the actuation space 32 of the working cylinder, - that is to say, one-way flow is permitted only if the pressure difference between the inflow and outflow side is in excess of the value established for said pressure reduction valve.

A second adjustable pressure reduction valve 47 is arranged in parallel placement in a line 46, which circumvents the named pressure reduction valve 46 - said pressure reduction valve 47 likewise only permitting hydraulic medium flow from the actuation area 32 of the hydraulic element 10 towards the pressure reservoir 41 if the respectively established value is surpassed. Moreover, manometers 48, 49 for pressure control are connected to the two high-pressure lines 42, 43 of the hydraulic system.

Also, the hydraulic system 40 comprises a hydraulic medium tank 50 from which, by means of a pump 52, via a line 53, equipped with a recoil valve 54 permitting only one-way flow, hydraulic medium can be transported into the pressure reservoir 41. Another line 56 issues into the tank, which continues to extend from the pressure reservoir and which can be shut-off by means of a manually operable shut-off valve 57. Finally, on the side of the hand-operable shut-off valve 44, facing away from the pressure reservoir, another line 58 branches off from the high-pressure line 43 joining the pressure reservoir with the hydraulic elements, which likewise issues into the

hydraulic medium tank 50 and into which has been inserted another adjustable pressure reducing valve 60, which only permits flow of hydraulic medium in direction toward the hydraulic medium tank, if the pressure difference between the inflow side and outflow side of the pressure reduction valve exceeds the value established for said valve. In addition, on the outflow side of the pressure reduction valve 45, there is connected to the pressure line 42, a line 61 with a hand-operable shut-off valve 62, which leads towards the hydraulic medium tank 50.

With proper utilization of the above described hydraulic element 10, for example for construction of a deep-drawing tool, the hold-down device of the tool is arranged on the ring piston 15, but the drawing punch on the central working piston 14. With respect to said kind of tool - which is not shown - the hold-down device is at the onset of the drawing operation in its upper position, consequently also the ring piston 15 receiving the hold-down device, which then supports itself on the rear side against the hydraulic medium received in the actuation space 32. This operating position is depicted in the left half of Fig. 1. The central working piston 14 receiving the drawing punch, is positioned, however, in its lower position, which is likewise depicted in the left-hand semi-sectional view of Fig. 1.

If, following insertion of a blank into the tool, the drawing process is initiated by lowering the drawing ring of the tool, the blank positioned on the hold-down device first experiences tensioning between drawing ring and hold-down device, and inside the actuating space 32 of the working cylinder flow medium pressure develops which actuates the central working piston on the rear side and drives it in the opposite direction of the descending ring piston 15. During this step, the hydraulic medium acting upon the differential area 27 is also displaced from the central actuation chamber 28 of the central working piston 14 and drains via the high-pressure line 43, 43' into the pressure reservoir 41 of the hydraulic system 10.

In said working mode, where no flow of hydraulic medium occurs between the actuation space 32 of the working cylinder and the hydraulic system 10, the two co-axially to each other arranged pistons 14, 15 thus undergo movement in the opposite direction, whereby the flow medium displaced during the descent of the ring piston 15 acts upon the central working piston 14 on the rear side, and, consequently, driving it so that at the end of the drawing operation the ring piston 15 is positioned upon the base plate 13 of the working cylinder, while the central working piston 14 occupies its upper-most position. Said operating status is depicted in the right semi-sectional view of Fig. 1.

Following upward-drive of the not illustrated drawing ring of the tool, and elimination of force which pushes the ring cylinder 15 in its lower position, there takes place a return of the hydraulic element 10 into the original position shown in the left semi-sectional view of Fig. 1, in that flow pressure medium flows from the pressure reservoir 41 via the high pressure line 43, 43' into the central actuation chamber 28 of the working piston 14, resulting in actuation of the differential area 27, which counter-acts actuation of the rear-sided actuation area 30 of the central working piston. Return of the hydraulic element and , consequently, of any drawing device constructed with the employment of same into their respective original position thus takes place automatically.

The hydraulic element 10, however, can also be used for construction of a combination drawing- and cutting tool and can then be controlled by means of the invention-specific hydraulic system 40.

With a combination drawing and cutting tool, a cutting operation takes place at the end of the drawing process, during which the drawing piece must be lowered down in its entirety, as opposed to the fixed cutting edges of the tool. This takes place in a manner that the drawing operation itself is finished before the ring piston 15 supporting the hold-down device stands upon the base plate 13 of the working cylinder, i.e. having reached its lowest position. Means for limiting the drawing operation are not shown in more detail.

At the end of the drawing operation, a rise takes place in the pressure of the hydraulic medium, which acts upon the rear-sided actuation areas 30, 31 of the two pistons 14, 15 and surpasses the pressure established at the pressure reduction valve 47, in the parallel branch 46, with the result that now ring piston 15 and working piston 14 move down together in order to execute the cutting process, and during this process, the hydraulic medium, which was displaced from the actuation space 32 of the working cylinder, flows into the pressure reservoir 41. After completion of the cutting process, as soon as the press ram of the stamping machine receiving the tool moves upward, there occurs a strong drop in pressure in the actuation space 32 of the working cylinder and the flow medium pressure of the pressure reservoir 41, which is present at the pressure reduction valve 45, located in the high pressure line 42, surpasses the value established at said pressure reduction valve, so that hydraulic medium flows into the actuation space 32 of the working cylinder, thus causing the ring piston 15 to move into its upper end position illustrated in the left semi-sectional view of Fig. 1.

While the ring piston moves upward, the central working piston remains in its lower position, because outside the central actuation chamber 28, which is in communication with the pressure reservoir 41, the differential area 27 of the central working piston 14 is acted upon by the high pressure originating from the pressure reservoir. The force holding the central working piston 14 in its lower position as a result of said actuation, is greater than the actuation of the rear-sided

actuation area 30 of said piston, inasmuch as the pressure reduction valve 45 shuts off the in-flow of hydraulic medium into the actuation space 32 of the working cylinder, as soon as the pressure difference occurring at the pressure reduction valve falls below the set value. Here again, the original position is thus attained automatically.

The invention-specific hydraulic system 40 provides another safety [measure] if - with appropriate use - inadmissibly high pressures occur in the actuation space 32 of the hydraulic cylinder or in the central actuation chamber 28 of the working piston 14. The hydraulic medium which flows via the adjustable pressure reduction valve 47 located in the parallel branch 46, or [flows] out of the actuation chamber 28, can in this case be directly passed into the hydraulic medium tank 50, via line 58 which continues from the high-pressure line 43 of the hydraulic system and the third pressure reduction valve 60, which is arranged in line 58.

Finally, the hydraulic system 40 also facilitates constant circulation of hydraulic medium via pump 52 and line 56 with the hand-operable valve 57, for example via a cooler, which is not depicted.

Moreover, the hydraulic system has on the out-flow side of the adjustable pressure reduction valve 45, line 61 with manually adjustable shut-off valve 62, which is connected to line 43 leading to the actuation space 32 of the hydraulic cylinder. If necessary, hydraulic medium can be drained from the actuation space of the working cylinder into the hydraulic medium tank 50.

Patent Claims

1. Hydraulic system for construction of a hydraulic element intended for tools used for drawing-, or forming operations or the like, which comprises, within a working cylinder, two co-axially vis-a-vis each other arranged and respectively jointly rear-sidedly activatable pistons, as well as a differential area, which is assigned to one of said pistons and whose rear-sided actuation, in opposite direction, can be acted upon with flow pressure medium, **characterized in that** a central actuation chamber (28) of the hydraulic element (10), which is sealed off from the differential area (27), is connected, via a pressure medium line (43) on the one side and, on the other side, an actuation space (32) sealed off from the rear-sided actuation areas (30, 31) of the two pistons (14, 15), by means of a pressure medium line (42) with a pressure reservoir (41) subjected to a pre-determined flow medium pressure, that in the last-named pressure medium line (42) is arranged an adjustable one-way pressure reduction valve (45), which permits hydraulic medium flow only from the pressure reservoir (41) to the actuation space (32) in case there occurs, at said valve, between the inflow and outflow side, a difference in pressure which is greater than the respectively established value, and that in parallel switching relative to the aforementioned pressure reduction valve (45), in a parallel branch (46) of the pressure medium line (45) there is arranged another adjustable one-way pressure reduction valve (47) which permits hydraulic medium flow from actuation space (32) to the pressure reservoir (41) only if the difference in pressure between the inflow side and the outflow side surpasses the value established at said valve.

2. Hydraulic system according to Claim 1, characterized in that from the hydraulic medium line (42) leading to the rear-sided actuation space (32) of the pistons (14, 15) of the hydraulic element (10), between the pressure reduction valve (45) and the pressure reduction valve (47) arranged in parallel path (46), there extends a hydraulic medium line (58) on the one side, and the pressure reservoir (41) on the other side, with said hydraulic medium line (58) issuing into a

hydraulic medium tank (50) and into which is inserted another adjustable one-way pressure reduction valve (60), which permits drainage of flow pressure medium to the hydraulic medium tank (50) only if the pressure difference between the inflow- and outflow-side occurring at said valve is greater than the specified value.

3. Hydraulic System according to Claim 2, characterized in that the hydraulic medium tank (50) is connected with the pressure reservoir (41) via a line (53) with a therein inserted conveyor pump (52) and a one-way recoil valve (54) permitting only transport of hydraulic medium from the tank (50) to the pressure reservoir (41), and that there extends a line (56) from the pressure tank (41) to the hydraulic medium tank (50) which is equipped with a shut-off organ (57) that can be operated between an open and a closed position.

Included: 1 page drawings
